DOCUMENT RESUME

ED 424 289 TM 029 172

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TITLE Low SES Algebra 1 Students and Their Teachers: Individual and a Bi-directional Investigation of Their Relationship and Implicit Beliefs of Ability with Final Grades.

PUB DATE 1998-04-00

NOTE 46p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).

PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.

DESCRIPTORS *Ability; *Algebra; Beliefs; *Disadvantaged Youth; Grades (Scholastic); High School Students; High Schools; Intelligence; Low Income Groups; *Mathematics Achievement; Mathematics Education; Research Methodology; *Secondary School Teachers; Sex Differences; *Socioeconomic Status; Teacher Expectations of Students

ABSTRACT

Mathematics achievement and the relationship of low socioeconomic status (SES) students with teachers have been a major concern for educators. Although there are social and economic explanations of failure of low SES students, ultimate success and failure may be significantly affected by differing personal beliefs about learning among students and teachers. C. S. Dweck's implicit beliefs about intelligence and mathematics were examined using a bi-directional methodology with R. D. Lang's Interpersonal Perception Method (IPM) in algebra 1. Incremental/entity beliefs, gender of students, gender of teachers, and low achievers and high achievers were subjected to an analysis of variance. Eighty low SES students and 43 male and 37 female teachers responded to the incremental beliefs that reflected abilities as changing and increasing with effort and to entity beliefs that reflected abilities as unchanging or fixed. Individual incremental female students confirmed the prediction that incremental believers would have higher final grades than the female students endorsing entity beliefs. Students matched with incremental-belief male teachers confirmed the dyadic prediction that incremental intelligence beliefs would lead to higher achievement than for a dyad endorsing entity beliefs. Dweck's personal theory integrated with the IPM examined several complex issues about real students' and teachers' experiences. Examining these experiences revealed some adaptive and maladaptive patterns that lead to math achievement for the low SES female student. Issues of methodology for examining student teacher relationships, power of projections over accuracy of perceptions (particularly for female students' expectations from their teachers), and the necessity of collecting data from both students and teachers for a clearer understanding of the issues affecting low SES students' math achievement are discussed. (Contains 1 table, 10 figures, and 44 references.) (Author/SLD)

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ED 424 289

Low SES Algebra 1 Students and Their Teachers: Individual and a Bi-directional Investigation of Their Relationship and Implicit Beliefs of Ability with Final Grades

by

Stephen A. Schullo and Burton L. Alperson

Abstract

Math achievement and the relationship of low SES students with teachers have been a major concern for educators. Although there are social and economic explanations of failure of low SES students, ultimate success and failure may be significantly affected by differing personal beliefs about learning among students and teachers. Dweck's implicit beliefs of intelligence and math were examined using a bi-directional methodology with Laing's Interpersonal Perception Method (IPM) in algebra 1.

Incremental/entity beliefs, gender of students, gender of teachers, and low achievers and high achievers were subjected to an ANOVA. Eighty low SES students and 43 male and 37 female teachers responded to the incremental beliefs that reflected abilities as changing and increasing with effort, and to entity beliefs that reflected abilities as unchanging or fixed. Individual incremental female students confirmed the prediction that incremental believers lead to higher final grades than those female students endorsing entity beliefs. Students matched with incremental male teachers confirmed the dyadic prediction that incremental intelligence beliefs would lead to higher achievement than the dyad endorsing entity beliefs.

Dweck's personal theory integrated with the IPM examined several complex issues about real students' and teachers' experiences. Examining these experiences revealed some adaptive and maladaptive patterns that lead to math achievement for the low SES female student. Issues of methodology for examining student teacher relationships, power of projections over accuracy of perceptions, particularly the female students' expectations from their teachers, and necessity to collect data from both students and teachers for a clearer understanding of those issues affecting low SES students' math achievement were discussed.

Paper presented at the Annual Meeting of the American Educational Research Association in San Diego, CA on April, 1998.

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Since the 1970's motivational theorists studying achievement related behaviors revealed how individuals construe, interpret, and process information about the learning situation (Dweck, 1986; Hae and Wong, 1996). Consideration of dispositional factors has revealed some adaptive behaviors important to achievement and some maladaptive behaviors detrimental to achievement (Dweck, 1986; Dweck, & Bempechat, 1983; Dweck & Henderson, 1989; Dweck & Leggett, 1988; Stipek & Gralinsky, 1996).

In spite of this important new emphasis, there are several problems with the current literature. As Stipek and Gralinski (1996) have pointed out, most research has focused on children from middle-class families with European American backgrounds. Additionally, with the exception of Skinner and Belmont (1993), no studies could be located that examined the reciprocal effects of teachers' implicit beliefs and their implications for creating a maladaptive or adaptive learning environment with students. Ames (1992) asserted: "...teachers structure the classroom, and their own goals most assuredly influence their beliefs about the efficacy of certain strategies and their instructional decisions." (p 268)

Without a doubt, teachers' beliefs are especially important with a classroom of low achieving and from low socioeconomic status families. The lower achievement and motivation of low SES students when compared with middle and high SES students (Bowman, 1994; Brophy, 1988; Cuban, 1989) has been a consistent finding in the literature. External explanations for the maladaptive behaviors leading to poor performance of many low SES students, for example, poverty, language and cultural discontinuity between home and classroom (See Bowman, 1994; Cuban, 1989; Erickson, 1987; Ogbu, 1992, for reviews) have been invoked as explanatory principles.

While much has been learned by studying these external factors, there are few studies that attempt to apply established dispositional research findings to low SES students and their teachers (Stipek & Gralinski, 1996). The Stipek & Gralinski study is an exception with elementary students from low SES families, no studies were located that focused exclusively on high school algebra 1 students. The present study broke away from external explanations of low SES student performance to examine the inner dynamics of students/teacher individual perceptions and interpersonal perceptions of their Theories of Intelligence (whether intelligence is innately fixed) and Theories of Math Abilities (whether math abilities are fixed).

The major purposes of the present study are (1) to explore the subjective dynamics defined by Implicit beliefs of Intelligence (Dweck, 1988) and Math abilities (MacGyvers, Stipek, Salmon, & Bogard, 1993) and to examine association of these motivation constructs with algebra 1 performance, and (2) to examine the student teacher relationship with a bi-directional

instrument, the Interpersonal Perception Method (IPM, Laing, Phillipson, & Lee, 1966) to better understand the role of students and teachers working together towards the goal of an adaptive learning environment.

Theories of Intelligence and Math Ability

The Theories of Intelligence and Math Ability constitute individuals' perceptions of what accounts for their intelligence and ability (Graham, 1991). They are personal, naive theories or implicit beliefs that people either consciously or unconsciously hold. The advantage of personal theories over an "academically defined theory" was that individual point of view forms the bases for empirical analyses. While not perfect, personal theories may more directly reflect people's subjective processes than other motivational theories. This becomes quite clear when the participants under study are other than European American backgrounds.

The implicit beliefs examined in this study represented by two subscales: (1) individual's intellectual ability, a broad-based competency, and (2) math abilities, a specific subject competency. While the intelligence items reflected intellectual ability and math items reflected math ability, both sub-scales reflected the c nceptually developed beliefs that are explained in detail in the incremental/entity belief section next.

Incremental/Entity Beliefs. Dweck and her associates (1988) further defined implicit beliefs into two opposing categories that are conceptually similar to the ability/effort dichotomy mentioned above. Incremental belief reflected individuals who perceive their intelligence and math abilities as changeable and controllable (adaptive). Intelligence and math ability can improve with effort. Conversely, entity believers felt that their intelligence and math abilities are rigid and uncontrollable (maladaptive or fixed), and that no amount of effort will change the innately fixed level of intelligence and math abilities.

The empirical evidence was clear that these two belief orientations reflect adaptive and maladaptive behavior connecting to achievement. The incremental belief is the adaptive behavior whereby the student perceives a challenging learning situation as an opportunity to exercise and increase his or her skills, competence, and learning. The entity belief is the maladaptive behavior where the students chronically shun a challenging problem, thereby, missing an opportunity to increase skills and ultimately learn. An entity believer usually wants to display a positive image by competing and outperforming others with trivial and risk-free academic tasks. Previous empirical research found that incremental believing students related to higher mastery orientation, motivation, and achievement than those students holding an entity belief (Dweck, 1986; Dweck, & Bempechat, 1983; Dweck & Henderson, 1989; Dweck & Leggett, 1988; Stipek

& Gralinsky, 1996). Thus, it was predicted that incremental believers would out-perform the entity believers on final grades.

Teacher Beliefs. Along with the students, teachers' beliefs were also assessed to examine how students and teachers personal theories affect student performance. One hypothesis to be examined empirically comes from Dweck & Bempechat (1983) and Dweck and Leggett (1988). They stated that teachers who believe that intellectual abilities are rigid would have a low expectation of student performance than teachers who believe that intelligence was adaptive. They specifically stated that this dichotomy would be clearly seen with students perceived as "less smart." Likewise, Brophy (1988) stated that low SES students need more encouragement, praise, and support for their efforts than middle class students. Thus, if the frequent observations and complaints by teachers is that low SES students are at best unmotivated, passive, and indifferent to learning and, at worst, openly hostile to teachers and schools is valid (Kagan, 1990; Wehlage & Rutter, 1986), few would argue against the notion that reaching, caring, and teaching low SES students would be more challenging than teaching middle class and upper middle class students in suburban schools. Thus, it is predicted in this study that teachers who believe that their student's intelligence and math ability are adaptive and changeable (incremental believers), will have students outperforming students with teachers who believe that intelligence and math ability are fixed (entity believers).

In the comparing of student and teachers' implicit beliefs, a bi-directional methodology was used. The bi-directional approach allowed for a direct comparison of each student and teacher's direct and counter perceptions (what each thought the other believed) by three independent variables: gender of teacher, gender of students, high/low final grade by median split. It is predicted that students and teachers who shared similar beliefs in intelligence and math abilities will outperform those students who are either mismatched, disagreed with or feel misunderstood with teachers. The IPM bi-directional approach and scoring are explained in the Methods section.

Algebra 1

Algebra 1 classes were selected for two primary reasons: (1) The national and state governments recognized that quality math and science instruction is an important education goal (National Council of Teachers of Mathematics, 1989; American Association for the Advancement of Science, 1989; both cited in Gehrke, Knapp, & Sirotnik, 1992). (2) Lay persons, students, and educators alike have sometimes diverse beliefs regarding the learning of math when compared to other subjects.

Some people feel that math can be learned best by putting forth effect and others belief that individual ability or talent works best. One belief seems to be more certain than others and has been reported by Stipek and Gralinski (1996). They cited several studies, which reported that students viewed science and mathematics as difficult subjects when compared to other subjects such as reading or social studies. The difficulty level of math raised concerns about the beliefs associated with the ability/effort belief dichotomy and are teachers creating a mastery learning environment (Ames, 1992ab) by endorsing similar beliefs that have been empirically demonstrated to be adaptive to student learning. These issues pertaining to low SES students were explored in this study.

Summary and Purpose

The primary purpose of this study was to investigate the self-perceptions and interpersonal perceptions of implicit beliefs of ability of low SES algebra 1 students. A bi-directional methodology assessed the implicit beliefs of the General Theory of Intelligence and the new Math beliefs. The Interpersonal Perception Method assessed the agreement, expected agreement, and understanding and their accuracies of their perceptions between students and their teachers about the intelligence and math belief items. The students' and teachers' beliefs and IPM perceptions were related to real world performance outcomes, namely, final grades.

Poor achievement and poor motivation of low SES students have been a major concern for educators. To address this issue, this study extended the original General Theory of Intelligence into three areas: low SES students, bi-directional examination of students' and teachers' implicit beliefs, and student performance. Dweck's General Theory of Intelligence may assist in understanding the underlying processes that guide adaptive and maladaptive achievement behavior of this student population. Despite the several legitimate and powerful external factors affecting low SES student achievement, much of the success or failure happens in the classroom in interactions between students and teachers (Erickson, 1987; Losey, 1995). Therefore, teachers were included in this study to examine bi-directional effects of both adaptive and maladaptive student teacher relationships. Finally, algebra 1 is a crucial math class deemed important by state and federal governments. This study extended the implicit theory to examine its validity outside the laboratory with math achievement in real classes and schools.

Methods

Subjects

Participants were 80 student-teacher dyads (160 total; 40 female & 40 male students, 37 female and 43 male teachers) in algebra 1 public school classes in 33 school districts from

southern and central California. Twenty-nine teachers were from Los Angeles Unified School District, the largest number of teachers from one district.

Data were collected via pencil and paper questionnaires. Each dyad consisted of one teacher and one randomly chosen low SES student. Data were collected during the spring, 1994, and 1995 semesters. At the end of the semester, final grades were given to the investigator. Algebra 1 grade levels ranged from seventh through twelfth grade. Eighty two percent of students were in the ninth and tenth grades (Mean ages were M=15.5, SD=1.34). All students were identified low SES by their teachers and confirmed by students reporting his or her parents' occupation. The student sample consisted of 49% Latino/a, 19% European American, 19% Asian American, 8% African American, 2.5% Native American and 2.5% "other" or did not self-identify.

The teachers' ages ranged from 24-66 (M=42.5, SD=10.6) and had a mean of 13.7 years of experience teaching low SES students (SD=9.97, range 1-40 years of teaching experience). The majority of teachers were European American (75%) with 9 Asian American (11%), 5 Latino/a (6%), 2 African American (2.5%) and 4 "other" (5%). Five teachers had been recognized with awards for outstanding teaching and five others were nominated for an award. Thirty-five teachers had earned a graduate degree and had at least a minor in undergraduate math. This information suggests that the sample was composed of highly trained, experienced and dedicated teachers. Chi-square analyses indicated that this demographic information and gender of students and teachers including gender was distributed equally among the independent variables. All participants were volunteers.

Implicit Beliefs Questionnaire

The Theory of Intelligence instrument was identical to Dweck's scale and measuring procedure. Eighty low SES students and 80 teachers were categorized as either incremental theorist or entity theorist by the median split. Participants selected a point on a six-point scale ranging from 1, "Strongly Agree," to 6, "Strongly Disagree." For students, an example of an intelligence item was "I have a certain amount of intelligence and I really can't do much to change it." Math item was " Mathematical ability is something that remains relatively fixed throughout my life" (see Table 1). The teacher's questions were modified so that they were focused on the participating student; for example, "*This student's* intelligence cannot be changed very much...." Thus, the targets of the students' and teachers' perceptions were the students' beliefs about his or her intelligence and math ability. Thus, incremental theorist would reject the items by "disagreeing" with the item and an entity theorist would accept the items (Dweck & MacGyvers, 1989).

Interpersonal Perception Method (IPM) Questionnaire

The IPM is a versatile instrument that was used to examine heterosexual couples (Laing, et al., 1966; Alperson & Freeman, 1983), married heterosexual and long-term gay and lesbian couples (Schullo & Alperson, 1984), and friends and enemies (Charlin, Alperson, & Schullo, 1989). Each of these studies included items that related to the purpose and goals of the study. In the present study, the implicit belief items are the items pertinent to students and teachers. Additionally, the identical likert-type scale of Dweck's was superimposed within the IPM format without a loss of continuity and interpretation of results from either Dweck's or the IPM formats.

The IPM is based on four basic definitions (Alperson, 1977). An issue is defined as any statement with which a participant can agree or disagree. One of the issues in the present study is "My intelligence is something about me that can't change very much." The second definition is the direct perspective. This is a person's opinion about that item (i.e., agree or disagree). The phasing of the direct perspectives were no different than Dweck's original questionnaire. The third definition is called a metaperspective; this is how the person thinks the other would feel about that item. Finally, the meta-metaperspective is how the first person thinks the other thinks the person feels about that item. An example of the three perspectives is presented below as statements to participants.

The following is an example of a student responding to the IPM format. For each issue, the participant considered the three perspectives and responded 1 (strongly agree), 2 (agree), 3 (sort of agree), 4 (sort of disagree), 5 (disagree) or 6 (strongly disagree). Starting with the direct perspective, the participant chose 1, 2, 3, 4, 5 or 6 about the issue "My intelligence is something about me that can't change very much." For the metaperspective, the student predicted what the teacher would think about the students' intelligence and chose 1, 2, 3, 4, 5, or 6 about the same issue. For the meta-metaperspective, the student predicted what his or her teacher might think the student would say and chose 1, 2, 3, 4, 5, or 6. Each of the 10 issues was subjected to these three perspectives.

The teacher responded to the same issues as the student. Each questionnaire by the teacher was about the one student selected for the study (not about students in general). Therefore, for the teacher, the direct perspective, the metaperspective, and meta-metaperspective were worded regarding the participating student. For example, a direct perspective statement was "This student's intelligence is something about him or her that can't be changed very much." A metaperspective statement was "Your student would say: My intelligence is something about me that can't change very much." Finally, the meta-metaperspective was "Your student thinks you

would say: This student's intelligence is something about him or her that can't change very much."

The direct, metaperspective, and meta-metaperspective were taken across the five items representing the entity beliefs of general intelligence (Dweck, 1986) and the five math entity beliefs items (MacGyvers, Stipek, Salmon, & Bogard, 1993), for a total of ten items.

IPM Determinations. The determinations represent the bi-directional method of this instrument. The comparisons of the student's and the teacher's direct perspectives, metaperspectives, and meta-metaperspectives result in five dependent variables called determinations. The formal and semantic derivations and other applications of these determinations have been presented elsewhere (Alperson, 1975a, 1975b, 1977; Alperson & Friedman, 1983; Charlin et al., 1989; Schullo & Alperson, 1984). The five determinations generated in the present study differ only in that they are based on responses to intelligence and math items as the issue.

The first determination is Agreement. Agreement is the measure of the degree to which student and teacher echoed each other on a statement. This involves comparing the direct perspective of the student with the direct perspective of the teacher. For example, if the teacher and the student responded "strongly disagree" to the statement that "My intelligence is something about me that can't change very much" by both selecting 6, then they agree in their perceptions on this issue. Since the score for agreement is interdependent, the student and teacher in any given dyad must have identical scores.

There are two projections on the next level of determination: expectations of agreement and feelings of being understood. Projection involves the first person predicting what the second person might say or think. For example, the participant's expectations of agreement were the comparisons of his or her direct perspectives with his or her metaperspectives. For example, if the student chose "strongly disagree" for the issue "My intelligence is something about me that can't change very much" and also expected that his or her teacher would choose "strongly disagree" for "Your teacher would say about you that: Your intelligence is something about you that can't be changed very much," then the student expected agreement with the teacher on this issue. The projection feelings of being understood is the comparison of the participant's direct perspectives with his or her meta-metaperspectives. For example, if the student chose "strongly disagrees" with the statement "My intelligence is something about me that can't change very much" and predicted that his or her teacher would chose "strongly disagree" for "Your teacher thinks you would say that: My intelligence is something about me that can't change very much," then the student expected to be understood by the teacher on this issue.

The accuracy of the projections is the next level of determination. These accuracies are called the accuracy of expectations of agreement and disagreement and the accuracy of feelings of being understood and misunderstood. Accuracies are measures of the degree to which one's projections about the other person are confirmed. The accuracy of expectations of agreement and disagreement is a measure of the accuracy of the projection "expectations of agreement and disagreement." For example, if the student accurately predicted that there was agreement or accurately predicted that there was disagreement with the teacher, then the student knew when he or she was in agreement or disagreement. The accuracy of feelings of being understood/misunderstood is a measure of the accuracy of the projection "feelings of being understood and misunderstood." For example, if the student felt understood when he or she was understood, or felt misunderstood when he or she was misunderstood, then she or he knew when understanding or misunderstanding existed.

Boolean scoring techniques for the determinations were described in earlier papers (Alperson, 1977; Schullo & Alperson, 1984). These techniques were extended by translating the Boolean determinations into fuzzy logic determinations.[1] Each determination may be regarded as representing the degree to which the mean of the responses belong to a given membership class on a scale of zero to one. For example, if the determination for a student's understanding of a teacher's views on intelligence items is .65, this means that, on the average, the degree of understanding of these items is .65 on a scale that runs from zero to one.

It is generally accepted that when people genuinely agree, expect agreement, and feel understood by others, their relationship is positive (Schullo & Alperson, 1984). Thus, extending this idea for examination to the present study, when students and teachers agree or feel understood on beliefs associated to learning, achievement should be higher than those that disagree or feel misunderstood. Thus, the student teacher relationship defined by their agreement and understanding about these beliefs can be empirically tested and related to real world outcomes like final grades. The 4 independent variables of this study were (1) incremental/entity beliefs, (2) gender of students, (3) gender of teachers and high/low final grade categories. The 6 dependent variables are the five IPM determinations, (1) agreement, (2) expected agreement, (3) felt understood, (4) accuracy of expected agreement, and (5) accuracy of felt understood and (6) final grades (coded on the standard A-F 5 point scale with A=4 and F=0).

Results

Analyses Strategy

Data from the assessment of students' and teachers' implicit beliefs of intelligence and math and the relationship of their beliefs to final grades in Algebra 1 are shown in this section. While the math beliefs are interpreted separately from the intelligence beliefs, the same type of analyses tested beliefs in both domains. Entity or incremental beliefs are treated as dichotomous independent variables and simultaneously examine the predictions than incremental beliefs lead to higher achievement than entity beliefs that also involve gender of students and gender of teachers. Final grades in Algebra 1 were the achievement measure in all analyses involving achievement.

This section also provides an assessment of individual student and teacher's bi-directional beliefs, using the IPM methodology, and explores how these beliefs vary according to student gender, teacher gender, and how they relate to students' final grade. An important distinction in this section is that the intelligence and math implicit belief items shown in Table 1 are scored differently to test hypotheses involving implicit beliefs and hypotheses involving the IPM.

Implicit Beliefs versus Interpersonal Perception Method

This section focuses primarily on the results of General Theory and the results of the IPM as they relate to students' achievement. While both the General Theory and the IPM used the intelligence and math items, the scoring procedure and analyses of these items for the General Theory differ from those for the IPM. Thus, the distinction between the intelligence and math implicit beliefs and the intelligence and math items for the IPM will be clarified in the direct examination of Theory and the IPM sections below.

While all significant main effects and interactions are reported, only the highest order interactions are illustrated with figures. Also, the interpretations will focus only on the highest order interaction. Pair-wise comparisons were tested by the Fisher LSD test. These comparisons were used to identify specific means within interactions that were significantly different from each-other. They helped clarify interpretation of the interaction.

Direct Examination of Theory of Intelligence and Math Ability Beliefs with Final Grades

The direct test of the General Theory of Intelligence and Math used the categorical independent variable, implicit beliefs. Each participant was placed into one of two implicit belief categories: incremental or entity. Since there were two implicit belief domains (intelligence and math) and scores on them were not highly correlated, each participant was placed into either incremental or entity beliefs of intelligence and either incremental or entity beliefs of math.

Placement was based on the median split within specific groups (e.g., male students). Each participant was either incremental or entity in one domain (intelligence or math), but he or she could differ in categorization across the two domains. That is, it was possible for a student or teacher to be categorized as incremental in one domain and entity in the other domain.

Student Results. For implicit beliefs about intelligence, there was one significant finding for final grades). A significant two-way interaction, type of belief by sex of student was found $F(1,72)=6.76$, $p < .02$ (see Figure 1). Female students endorsing incremental beliefs had higher final grades than female students endorsing entity beliefs. Pairwise comparisons among the means revealed no evidence for differences among the male students.

The prediction that student incremental beliefs leading to higher achievement was confirmed by the intelligence beliefs and by the female students. No other significant differences among the math beliefs or male students were found.

Teacher Results. It was predicted that students' final grades would be higher with an incremental teacher than an entity teacher. For implicit beliefs of intelligence, there was one significant finding for final grades. A significant two-way interaction was found for gender of teachers and type of belief, $F(1,72)=5.42$, $p < .05$ (see Figure 2). When male teachers endorsed incremental beliefs of intelligence, their students had higher final grades than male teachers who endorsing entity beliefs. The prediction that students with incremental believing teachers would lead to higher grades than entity believing teachers was confirmed by the male teachers only. No differences were found for students of female teachers nor with the math beliefs.

Student-teacher Dyadic Matching of Shared Beliefs. Four types of student-teacher match-ups based on their implicit beliefs created this independent variable.

(1) entity teacher/entity student

(2) incremental teacher/incremental student

(3) incremental teacher/entity student

(4) entity teacher/incremental student

For both the intelligence and math beliefs, the number 2 dyad was predicted to out-perform the number 1 dyad. Students in number 3 and number 4 dyads were expected to fall somewhere between students in dyads number 1 and 2. One ANOVA was conducted for intelligence beliefs match ups and final grades, and was repeated for the math beliefs match ups and final grades. These analyses tested the simultaneous effects on student achievement of both the student's and the teacher's entity or incremental implicit beliefs.

A 4x2x2 ANOVAs tested the prediction. The independent variables are the four types of belief match ups (detailed above) by gender of student and gender of teacher and the dependent

variable was final grades. For implicit beliefs about intelligence, there was one significant finding for final grades. There was a significant gender of teacher by match interaction, $F(3,64)=3.58$, $p < .02$ (see Figure 3).

The prediction that both the student and their teacher matched on incremental beliefs would out perform those student-teacher dyads who both endorsed entity beliefs was supported only by male teachers. For the intelligence beliefs, incremental believing students matched with incremental male teachers had better final grades than entity students matched with entity male teachers. There were no other findings.

IPM Determinations Associated with Final Grades

The IPM assessed the relationship of students and teachers by examining their bi-directional perceptions of the intelligence and math items. The intelligence and the math items per se, not the incremental and entity categorical beliefs, were used in the IPM analyses. The important point is that for IPM analyses the scores were calculated based on the degree to which two perspectives on the same issue (from the same participant or from the student and the teacher) were consistent. (That is, the degree to which they shared membership in the same fuzzy category). Thus, to avoid confusion with the categorical beliefs that tested the General Theory, interpretation was limited to the IPM scoring method.

The scores for math and intelligence items of all five IPM determinations were ordinarily treated as a within-subject variable in Multivariate Mixed Model repeated measures ANOVA. This created an opportunity to examine the intelligence and math items separately and together, depending on the significance of this within-subject variable. Thus, intelligence items and math items are synonymous with the two levels of mode (defined as Intelligence on one level and Math on the other level) and should not be confused with the categorical implicit beliefs that was previously used in the direct test of the Theory. Students' and teachers' IPM scores were analyzed separately for ease of interpretation and to reduce possible multicollinearity problems in the multiple analyses.

The high/low final grade category was created for the Mixed Model ANOVA repeated measures analyses of the IPM determinations. Since both final grades and IPM determinations are dependent variables, the high/low final grade category placed students who had a 2.0 or lower in the low achieving group and those who had a final grade greater than 2.0 in the high achieving group. It was now possible to test predictions of low versus high achieving students' perceptual differences.

The IPM Determinations were tested in two stages. The first IPM determination tested was Agreement. The agreement score result is identical for both students and teachers. To

eliminate statistical redundancy, only the students agreement score was used in the analysis. The second stage tested remaining IPM determinations Expected Agreement, Felt Understood, Accuracy of Expected Agreement and Accuracy of Felt Understood and were analyzed separately for students and teachers.

Stage 1--Model for Agreement: Between-Subjects Factors are Gender of Students, Gender of Teachers, and Performance Level (High/low final grade). Within Subject Factors are Intelligence and Math items. The students' and the teacher's agreement was defined as a simple match of each direct perspective. It was predicted that high achieving students and their teachers would have more agreement on the intelligence and math items than the lower achieving students.

The agreement score was analyzed in a 2x2x2x2 Mixed Model repeated measures ANOVA. There was one significant main effect on agreement. A Mode main effect was found, $F(1,72)=4.26$, $p < .05$). All participants had more agreement on the Intelligence items than the math items (see Figure 4). This prediction was not supported with student performance.

Stage 2--Model for Expected Agreement, Feelings of Being Understood, Accuracy of Expected Agreement, and Accuracy of Feelings of Being Understood: Between Subject Factors are Gender of Students, Gender of Teachers, and Performance Level (High/low final grade). Within Subject Factors were, (1) Projections of expected agreement and feels understood, (2) Accuracies of Expected Agreement and Feelings of Being Understood, and (3) Intelligence and Math items.

Student Results: The were three main effects on projections and accuracies $F(1,72)=33.4$, $p < .000$), the main effect on expected agreement and feels understood taken across expectances and accuracies that were significant $F(1,72)=14.4$, $p < .000$), and the effects of the Intelligence and Math items $F(1,72)=6.9$, $p < .02$). On the first main effect, students have greater projections than the accuracies of these perceptions, which was predicted. On the second main effect, students had greater projections and accuracies of expected agreement than feelings of being understood and accuracies of feelings of being understood. On the third main effect, students' total perceptions were greater with the Intelligence items than the Math items.

Since there were three main effects and seven significant interactions, only the two highest order interactions will be reported and discussed. Refer to Figures 5a and 5b for illustrations. The first one was a projections and accuracies by expected agreement and feelings of being understood by low and high achievers of the male and female teachers $F(1,72)=4.24$, $p < .05$). The nature of this interaction is that for higher achieving students, their projections from male teachers are higher than their accuracies of projections and higher than any of the other

groups (i.e., higher than the female teachers and higher than the low achieving students). In other words, the high achieving students have higher expectations (projections) than accuracies, which was predicted for all students, not only students with male teachers.

The second 4-way significant ANOVA was a projections and accuracies by Intelligence and math items by low and high achievers by male and female students $F(1\text{-}72)=4.05$, $p<.05$). Refer to Figures 6a and 6b for illustrations. The nature of this interaction is that for high achieving female students' have greater expectancies and feelings of being understood than the low achieving female students. There are no discernable perceptual differences among the high and low male student achievers. Overall results for the students is that high achieving female students expect more and feel understood more from their teachers than low achieving students.

Teachers' Results. There were 2 significant main effects and 4 interactions. Only the highest order interaction will be reported and discussed in this paper. A significant 4-way ANOVA on expectancies and feelings of being understood by expected agreement and feelings of being understood by intelligence and math items by low achievers by high achievers was found $F(1,72)=5.99$, $p<.02$). Refer to Figures 7a and 7b for illustrations of this interaction. The nature of this interaction is that teachers expected agreement more from the high achieving students than the low achieving students. Additionally, teachers felt more understood, while expecting less agreement from the low achieving students.

Discussion

The primary purpose of this study was to investigate the self-perceptions and interpersonal perceptions of implicit beliefs of ability of low SES students and of teachers. Students and teachers were assessed for implicit beliefs of the General Theory of Intelligence (Dweck & Legget, 1988) and the new Math beliefs (MacGyvers, Stipek, Salmon, & Bogard, 1993). The bi-directional instrument, the Interpersonal Perception Method (IPM; Laing, et. al, 1966), assessed the agreement, expected agreement, and understanding of students and their teachers about the intelligence and math beliefs. Participants were 80 student-teacher dyads in algebra 1 public school classes from southern and central California. The students' and teachers' beliefs and IPM perceptions were related to real world performance outcomes, namely, final grades.

The discussion that follows will duplicate the pattern established in the Results section. Since there are numerous main effects and interactions, only the highest order interactions will be discussed.

Direct Investigation of the General Theory of Intelligence and Math Implicit Beliefs and Achievement.

Dweck's General Theory of Intelligence generally asserted that students holding incremental implicit beliefs would have higher achievement than would students holding entity beliefs. The former believe that intelligence skills are malleable, can change and improve with effort, while the latter believe that one's intelligence abilities are fixed and unchangeable. Thus, by definition, incremental believers see learning situations differently from entity believers (Dweck & Leggett, 1988). A major reason for this study was to examine whether and how this formulation pertains for low SES students and for teachers. It could be argued, for example, that among lower SES learners holding incremental beliefs would be especially supportive of higher achievement. While previous studies examined only elementary and junior high students' beliefs with students with European background, this study examined junior and senior high school algebra 1 students' beliefs and their teachers' beliefs.

Students' Beliefs. The present study found that the General Theory of Intelligence was supported in certain situations. First, the female students' endorsing incremental intelligence beliefs earned higher final grades than did the female students endorsing entity intelligence beliefs. This finding differs from previous studies of the Theory, in that, only the female students endorsing incremental beliefs lead to better grades. It supports many studies of the math classroom that female students are more at risk for failure than male students. Furthermore, for the low SES female student, this particular group may be more at risk than a group of middle class female students. While the present study did not include a comparison group of middle class female students, this could be an area for further study.

Teachers' Beliefs. The male teachers endorsing incremental beliefs gave out higher grades than the male teachers endorsing entity beliefs did. While the fact is that the Theory was once again supported, this was a surprising finding between the student and the teachers regarding gender differences. It was difficult to interpret this finding until more data on the effects of teachers' beliefs can be collected to see if a pattern is replicated.

Student/Teacher Dyadic Match-ups. It was predicted that students endorsing incremental beliefs matched with teachers also indorsing incremental beliefs would out perform all other match ups. Once again, the male teacher endorsing incremental beliefs with students also endorsing incremental beliefs had the highest final grades. A fairly clear pattern of supporting the General Theory of Intelligence points directly at male teachers and their female students. Both with individual male teachers and male teachers matched with students both indorsing incremental beliefs seemed to create the mastery environment that many researchers and practitioners report.

But the data here point to a two edged sword. When female students have a male math teacher, female students will do well when they and their male teacher both endorse incremental beliefs. Nevertheless, it has been reported that math classes are primarily a male dominated subject (Kimball, 1989). This may partially explain why female students are at greater risk for failing. The data of this study shows that if female students are entity believers and are matched with an entity male teacher, they are more at risk for failure than if they were with the female teachers or incremental male teachers. In general, female teachers' data have no such dichotomous patterns. The practical suggestion for male math teachers is to pay a little more attention to his female students.

Interpersonal Perception Method and Low versus High Achieving Algebra 1 Students

The purpose of most classroom process research is to examine and identify important factors that shape teachers' and students' experiences that lead to academic success or failure. The factors in the present study are defined as the interpersonal perceptions of a math teacher and one randomly chosen algebra 1 low SES student. At the beginning of this discussion, the implicit beliefs about intelligence and math abilities were considered in Dweck's framework, that is, as individual belief categories. Now, the discussion moves beyond the self-perceptions to the interpersonal perceptions of the student-teacher dyad. Thus, the student/teacher relationship was defined by their interpersonal perceptions about same intelligence and math items used to assess individual implicit beliefs.

Learning usually does not happen by accident. Students must communicate to their teachers what they know and do not know or understand. Likewise, teachers must communicate what they know about the content of the material in a personable and structured approach so comprehension is maximized for most students (Brophy, 1986, 1988). In the present study, the relationship of students and teachers was defined as the matching of the 3 IPM perspectives of self and other. In considering this relationship, it is important to remember that the operationalization of incremental and entity beliefs used to assess IPM hypotheses was somewhat different from that used to assess hypotheses drawn directly from Dweck's theory. The two operationalizations are presented in detail in the methods and at the beginning of the results section.

It can be argued that students and teachers who expect agreement with the other and feel understood by the other perceive themselves to have a reasonable working relationship. Previous research using the IPM method found that perceptions of agreement and understanding were more important than their accuracy in predicting relationship quality (Alperson & Schullo, 1991) and academic achievement (Schullo, 1991). The present study provided some additional support

for the phenomenon in that the projections, expected agreement and feelings of being understood, (The word "projections" defined in the results section is synonymous to "expectations.") predicted student achievement while accuracies of their projections would not.

Agreement. This determination revealed more agreement with the intelligent items than the math items. It is difficult to determine how or why students and teachers sharing more perspectives on the intelligence items (or goals in the description by Dweck and Leggett, 1988) was not associated with better student performance. Motivational theorists have agreed that shared goals among students and teachers are related to real world outcomes, such as final grades (Ames, 1992; Ames & Russell, 1984; Blumenfeld, 1992). However, MacGyvers (1992) reported that motivational patterns of low SES students may be markedly different than with European American students. If this is true and the results of this study point in that direction, it is imperative that more research be undertaken to define possible differing motivations patterns for mediational interventions of low SES students.

Students' Perceptions: expected agreement, feelings of being understood, accuracy of expected agreement and accuracy of feelings of being understood. It is predicted that students and teachers who expected agreement and felt understood about their beliefs of intelligence and math abilities will outperform those students who are either disagreed, expected less or felt misunderstood with teachers. There were two significant 4-way ANOVA findings from the students. First, lets look at the results involving one of the four factors--teacher gender. When observing Figure 5a, the perceptions of students' on male teachers, high achieving students expect more agreement and have more feelings of being understood than the accuracies of their perceptions. The low achieving students have fewer expectations than high achieving students. However, the accuracies of the high and low achieving groups are about equal. Referring to Figure 5b the students' perception of female teachers, a similar pattern existed with the expectations of the high achieving students over the low achievers. However, the accuracy of feelings of being understood are lower with both high and low achieving students.

The results clearly showed that the high achieving students also had higher expected agreement and feelings of being understood than the low achieving students. However, the qualifying factors of the high expected agreement and feelings of being understood IPM determination were gender of students. While the factor gender of students related to the finding of the direct test of the General Theory of Intelligence that female students endorsing incremental beliefs lead to higher final grades, a consistent finding was revealed with the female students relationship with their teachers. The high achieving female students had dramatically higher expectations than the female low achievers. The male students, on the other hand, no

differences were attributed to any of the groups. This finding clearly shows that in both the direct test of the Theory and the Interpersonal Perception Method results, the female students had better endorse incremental beliefs and have high expected agreement and feelings of being understood by their teachers. The male students on the other hand, seem to be relatively unaffected by neither the belief dichotomy nor the projections of the IPM. Furthermore, it was predicted that the projections or expectations would be associated with higher achievement than the accuracies of projections were supported.

The finding clearly supports studies conducted in math classes. It was found in the studies that Kimball (1989) cited that by the time females reach high school, they begin to consistently fall behind males in math achievement. Also, males take more math classes than females and males receive more teacher attention and interaction than female students in both social and academic situations and males are more active with answers during class discussions. In the present study, the males and females got exactly the same final grade, 2.4. However this finding is misleading for the reasons previously stated by the incremental believing females. Thus far, this discussion has been focused on the students' perceptual experiences. Lets now turn to the teachers' perceptions to see if the bi-directional method can shed more light on these issues.

Teachers' Perceptions. A consistent finding was observed in the teacher's perceptions. As predicted, teachers expected more agreement from the high achievers than the low achievers. For the low achieving students, there was a dramatic drop in teachers' projections on either the intelligent or math items (see Figure 7a). As predicted the accuracies of the perceptions were unaffected by the differing grade achievers (see Figure 7b).

While both projections were expected to relate with the high achievers, only one of the teachers' projection, expected agreement, was dramatically lower for the lower achievers, not the other projection, feelings of being understood. One explanation was that the object of the teachers' projection differs, the object of expected agreement puts the responsibility of the relationship on the student and the object of feelings of being understood puts the responsibility back on the teacher. For expected agreement, it is much easier for the teacher to expect that low achieving students will not agree with the teacher on issues relating to their intelligence and math abilities. Since this student was expected not to agree with the teacher, it takes the responsibility off the teacher and put it on the students.

For feelings of being understood, it would be more difficult for the teacher to think that their low achieving student does not know what the teacher is thinking about the student's intelligence and math ability. The teacher not only teaches the subject matter, but also lectures,

ad infinitum, to all his or her students that they are smart enough to learn math successfully, if you work hard, do one's homework, stay after school, and ask questions. To get this message across is the teacher's responsibility. Few teachers will admit that their students will not understand them on these issues and this may be the reason why the teachers' projection, feelings of being understood, was high for both the low and high achievers. This is a speculative explanation that would require further study.

Summary

Female students and not the male students supported the General Theory of Intelligence. This finding draws broad support from the major motivational theorists (Ames, 1992ab, Deci, 1991; Dweck & Leggett, 1988; McCombs, 1991; Nichols, 1984). They would argue that the incremental female students' higher achievement originated from the self through self-knowledge and beliefs (McCombs, 1991). The data supported the "self as agent" as the "primary role in motivation and behavior" (McCombs, 1991, p. 18) that is emphasized in the motivational literature. For the most part, incremental high achieving students were also with incremental believing male teachers. It was beyond the purpose of this study to identify the link that connects teachers' incremental beliefs and motivational goals and their students' incremental beliefs and goals to students' final grades. No evidence was found that linked entity believers to high final grades. Thus, it is safe to say that incremental believing teachers may be more beneficial than harmful to students' achievement and to the enhancement of students' adaptive beliefs. For low SES students, the evidence of this study shows that female students are more at risk for failure than the male students. Male students can endorse any belief system they desire and it is not detrimental to their performance in algebra 1.

The bi-directional data of the student/teacher relationship measured by the IPM supported the findings of the direct test of the Theory of Intelligence. Once again, only the female students who expected more agreement and felt more understood were clearly in the higher final grade group than those female students who had lower projection scores. The female student projections strongly related to outcome measures and this finding supported previous studies that found projections relating to satisfaction within romantic relationships (Alperson & Schullo, 1991), and to academic achievement (Schullo, 1991). For teachers and the male students, the results of their projections were less clear.

This study examined important motivational issues that reflected the Theory of Intelligence and math beliefs and was a basis for examining how teachers and students perceive each other on these same motivational constructs. Individual motivational has been shown to be important, even crucial to academic achievement and development from European Students from

middle and upper middle class families. However, for the low SES female student, there may be more involved to the "self as agent" as described by McCombs (1991). Teachers' and students' mutual agreement, expectation, and understanding of each other may also be important to the continuous development of the "self as agent" functioning of low SES female students' motivation and ultimate success in algebra 1.

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[1] The translation of determinations was accomplished by replacing Boolean operators with the appropriate Zadeh operators (Zadeh, 1965). Zadeh's operators involve substituting a MIN function for the Boolean AND, and a MAX function for the Boolean OR. Thus, the determination for Understanding will be scored as:

$$\text{Understanding} = [(\text{DirectPerspec} \times \text{MetaMetaPerspec}) + (\overline{\text{DirectPerspec}} \times \overline{\text{MetaMetaPerspec}})]$$

in Boolean logic. In the fuzzy logic translation, the same determination would be scored as:

$$\text{Fuzzy Understanding} = \max(\min(\text{DirectPerspec}, \text{MetaMetaPerspec}), \min(\overline{\text{DirectPerspec}}, \overline{\text{MetaMetaPerspec}}))$$

Table 1

General Theory of Implicit Belief Items

Intelligence Items

1. I have a certain amount of intelligence and I really can't do much to change it.
2. My intelligence is something about me that can't be changed very much.
3. I can learn new things, but I can't really change my basic intelligence.
4. If I am not as intelligent as they would like to be, there isn't much I can do about it.
5. How intelligent I am just isn't something that is likely to change.

Math Items

1. My mathematical ability is something that remains relatively fixed throughout my life.
2. I either have a talent for mathematics and I just don't.
3. Math ability is something that I have a certain amount of and there isn't much I can do to change it.
4. There isn't much I can do about how much mathematical ability I have.
5. I can improve my math skills, but I can't change my basic math ability.

Figure 1

Students' Beliefs and Student Gender

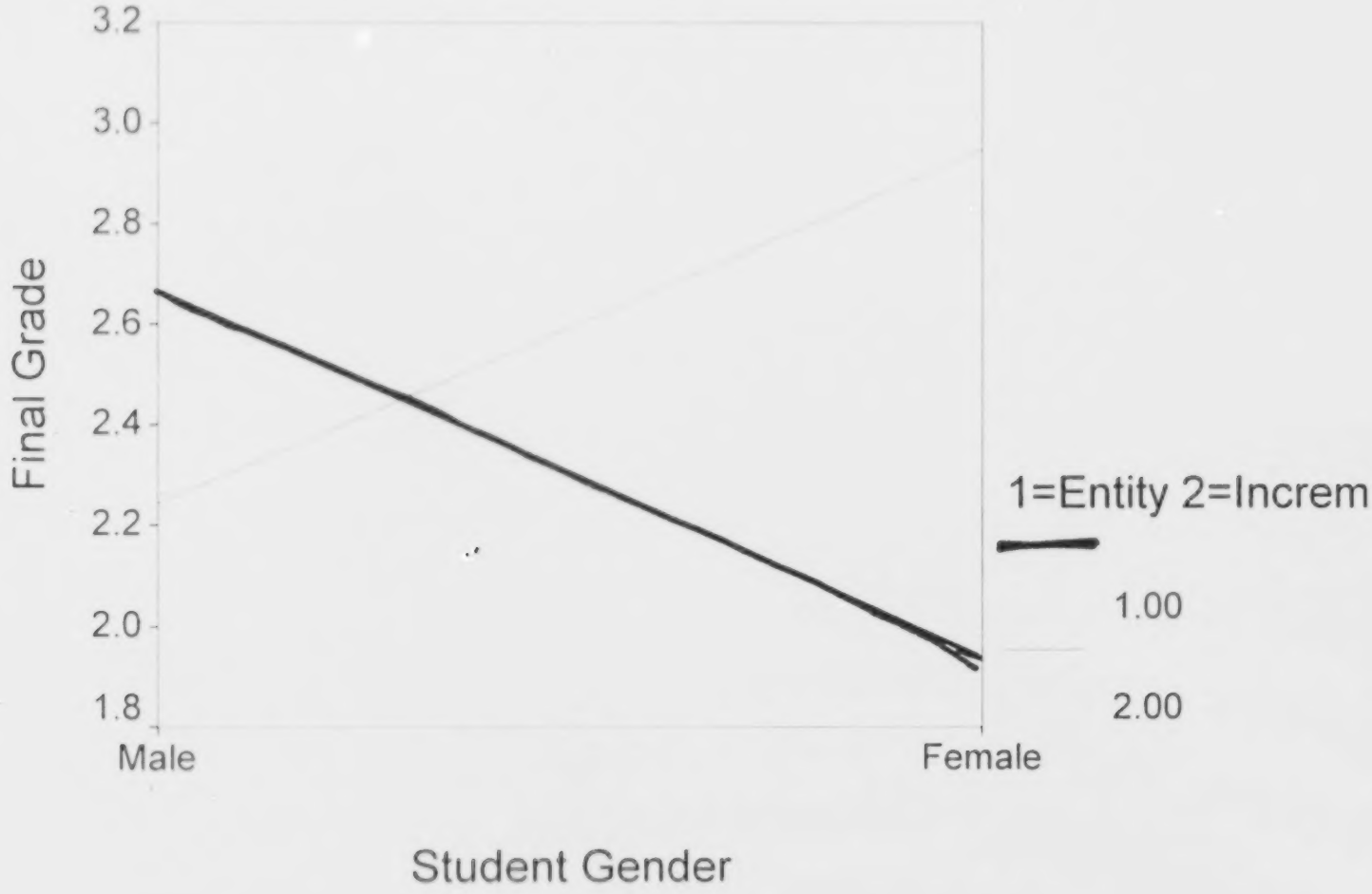

Figure 2

Teachers Beliefs and Final Grade

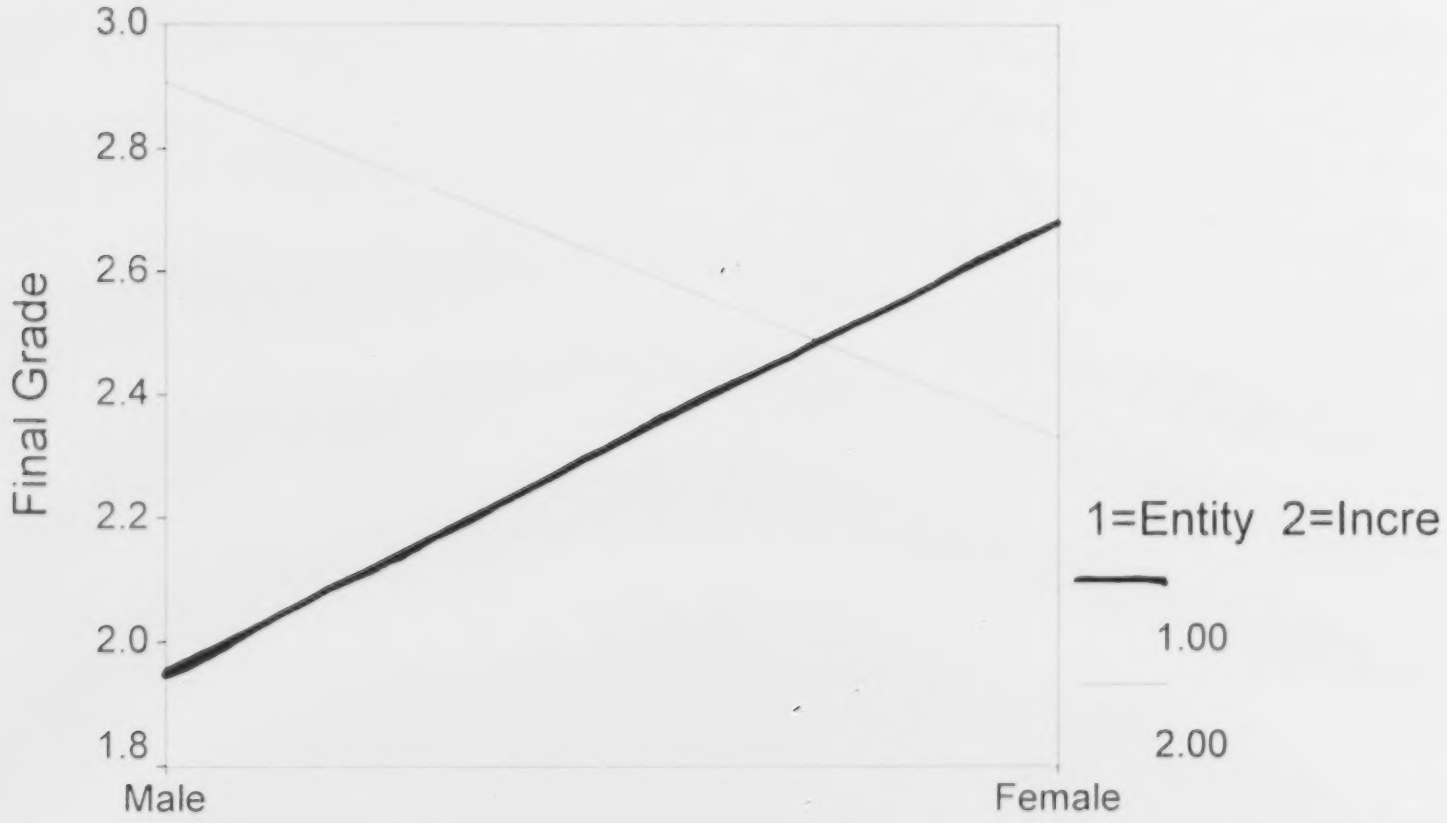

Figure 3

Beliefs Match: Dyad and Teacher Gender

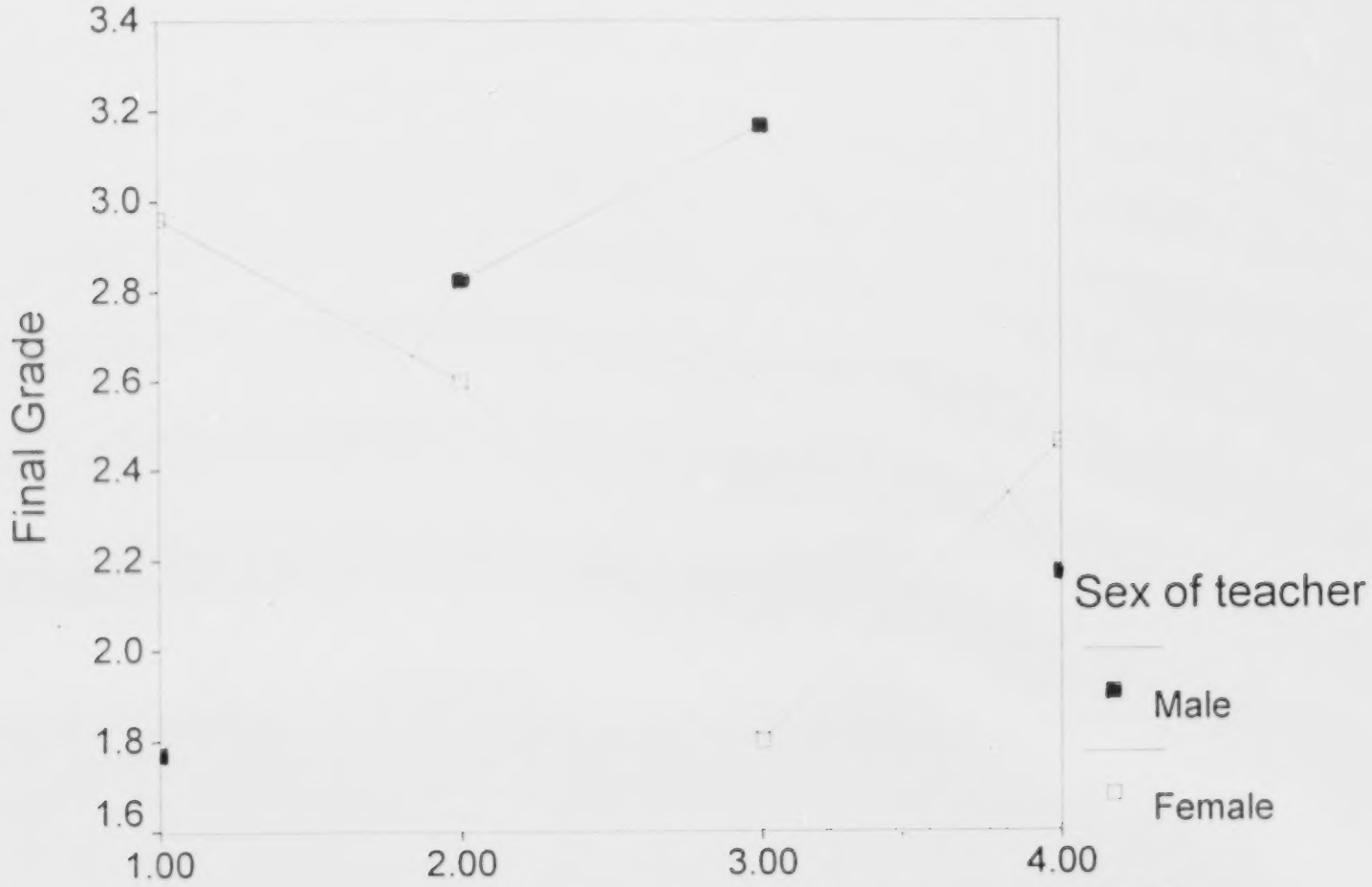

Figure 4

Agreement Main Effect

Figure 5a
Students' Perceptions of Male Teachers

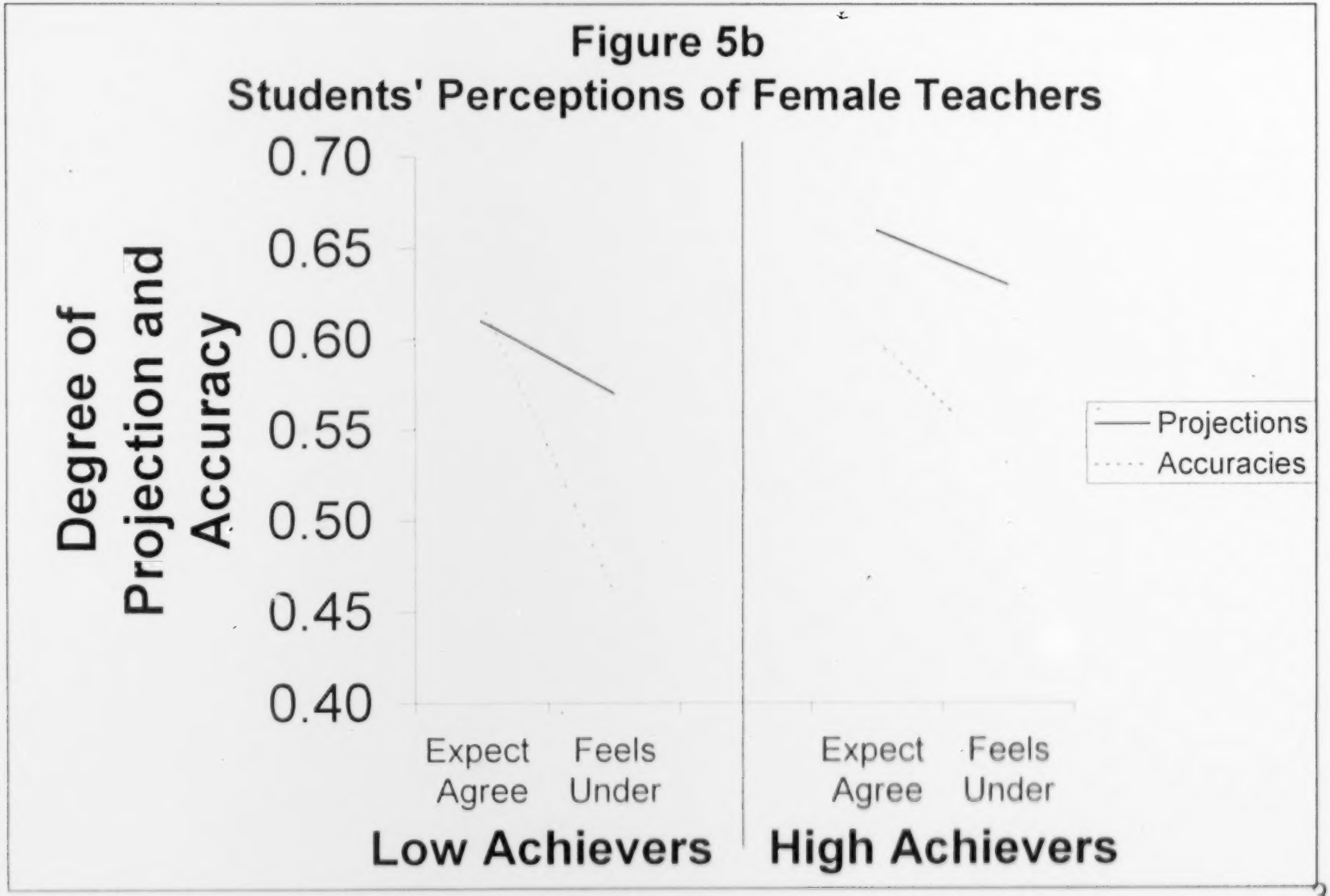
Figure 5b
Students' Perceptions of Female Teachers
Degree of Projection and Accuracy
0.70
0.65
0.60
0.55
0.50
0.45
0.40
Projections
Accuracies
Expect Agree
Feels Under
Expect Agree
Feels Under
Low Achievers
High Achievers

Figure 6a
Male Students' Perceptions

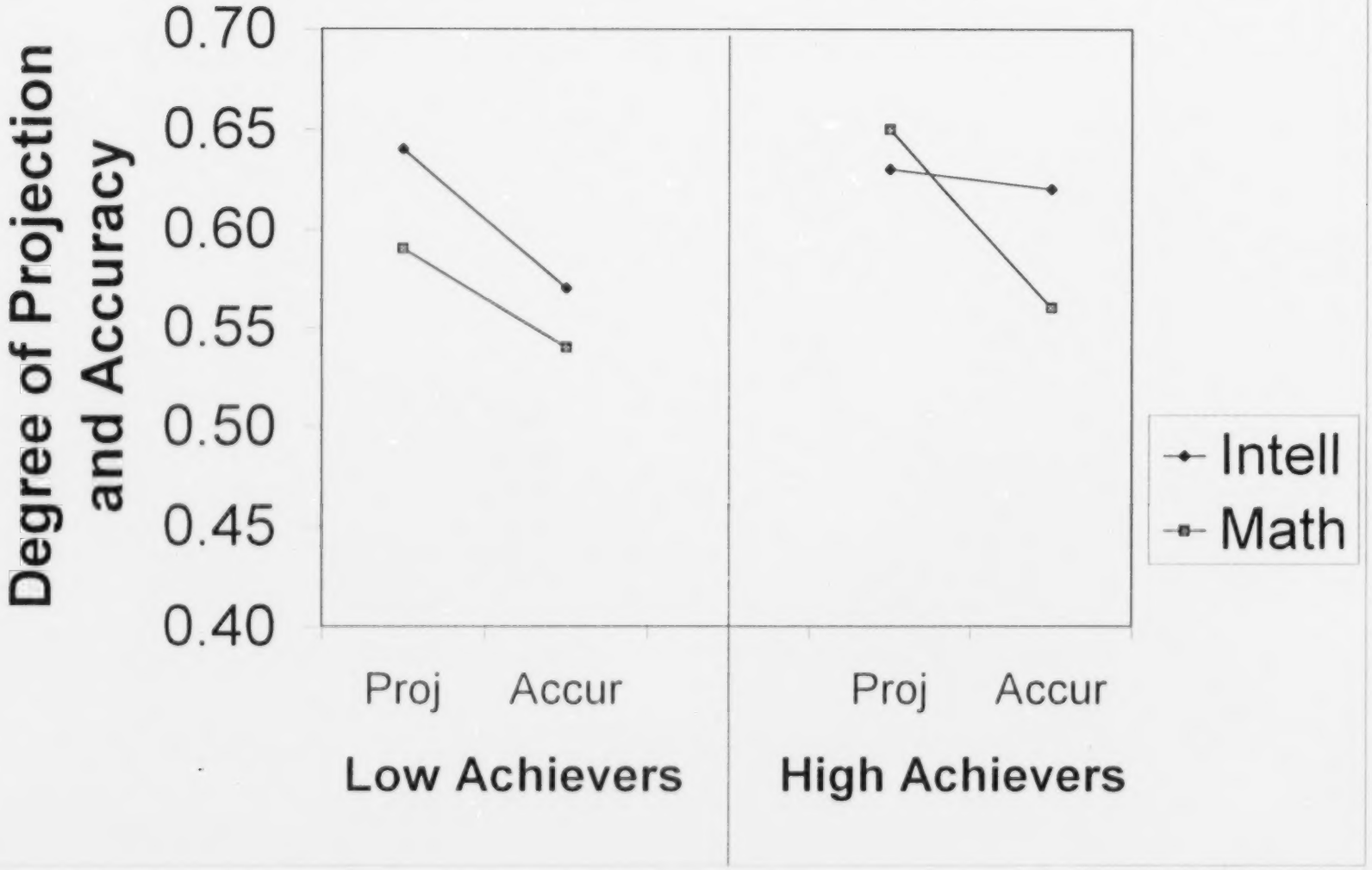

Figure 6b
Female Students' Perceptions

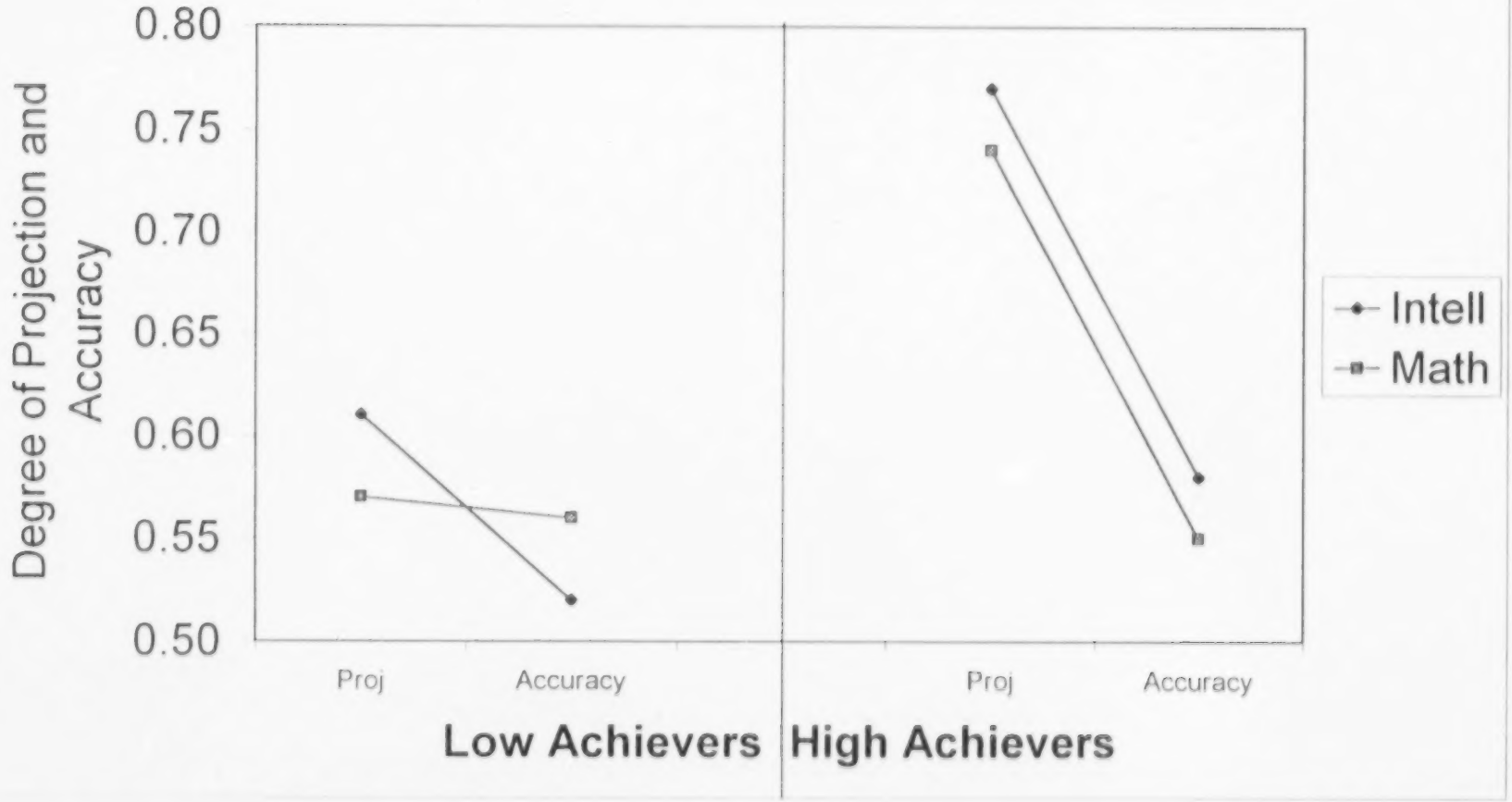

Figure 7a

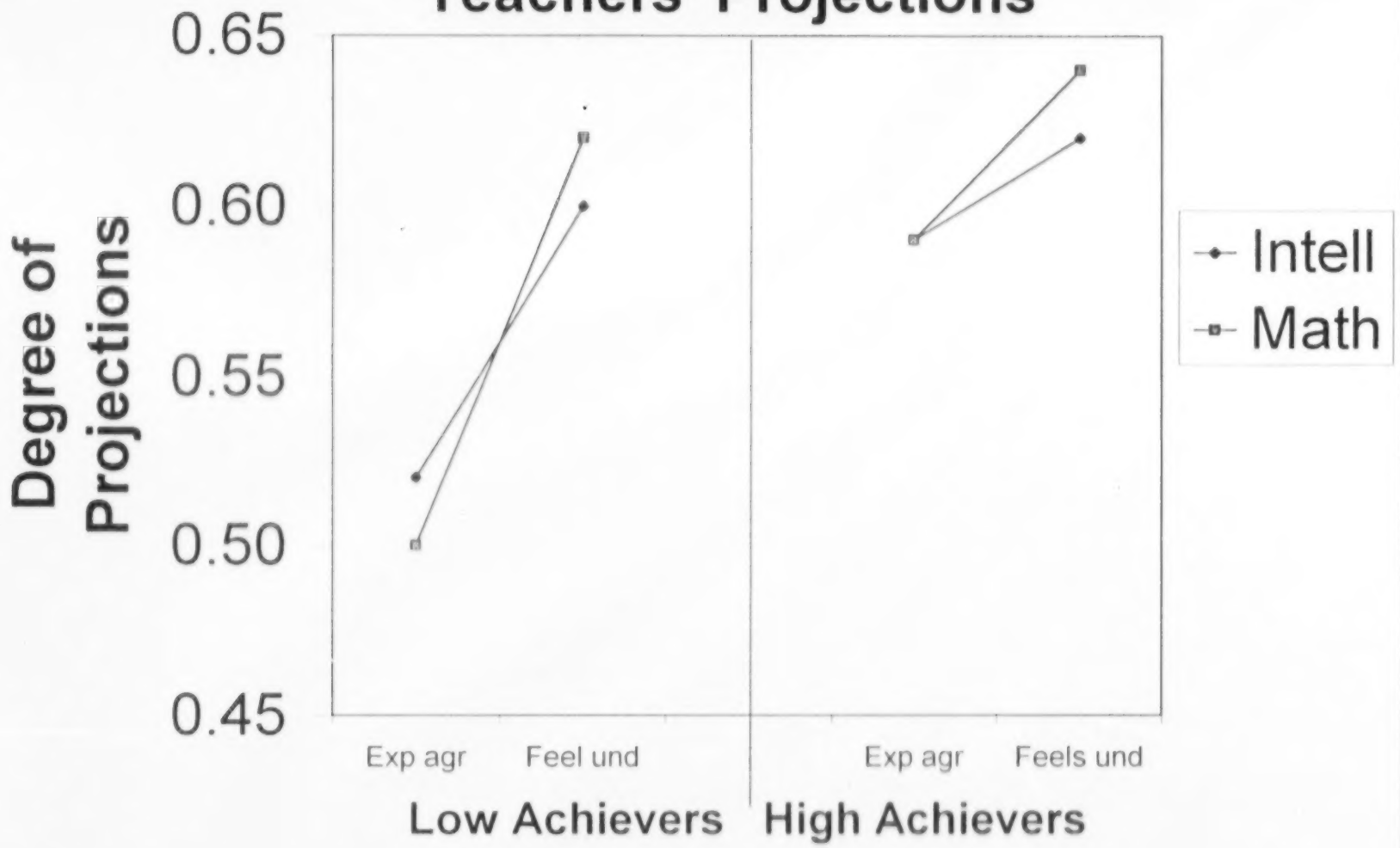
Teachers' Projections
Degree of Projections
0.65
0.60
0.55
0.50
0.45
Exp agr
Feel und
Exp agr
Feels und
Low Achievers
High Achievers
Intell
Math

Figure 7b

Teachers' Accuracies